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I, JULIE BILLINGSLEY, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. 2003903771 for a patent by NAUTITECH PTY LTD as filed on 21 July 2003.



WITNESS my hand this
Third day of November 2004

A handwritten signature in cursive script, reading "J. Billingsley".

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AUSTRALIA

Patents Act 1990

Nautitech Pty Ltd

PROVISIONAL SPECIFICATION

Invention Title:

Dual clutch transmission

The invention is described in the following statement:

Field of the Invention

The present invention relates to a dual clutch transmission. In particular, the invention relates to a dual clutch automated manual transmission which is particularly suited for use in marine applications but may also be used in other applications, particularly where a compact transmission is desirable.

Background of the Invention

In most existing marine drives in watercraft, a marine engine is coupled to a propeller via a gear box which provides a single gear ratio. The speed of the watercraft is controlled by controlling the engine speed via a throttle. Generally speaking, watercraft are geared so that they run most efficiently at their intended cruising speed. A large yacht may be designed to cruise at 35 to 40 knots and is thus geared to be most efficient and controllable at or around that speed. However a problem with this arrangement is that such craft are very difficult to operate at the low speeds that may be required for example, when docking the craft. It is very difficult to dock a boat safely if, for example, the lowest speed that the boat will satisfactorily travel at, is around 10 knots. It is also, in some cases, desirable to have a low gear ratio for applications where increased torque is required, with a higher gear ratio for high speed operation.

Although a number of multi-speed drive transmissions have been proposed for watercraft, they suffer from a number of problems. For example, US 6,350,165 discloses a watercraft which incorporates a two forward speed plus one reverse speed transmission. The transmission is based on a planetary gear apparatus and is consequently relatively high cost. The transmission has a further problem in that because of the way the gearing is arranged, it is not possible to vary the gear ratios easily, since all the gear wheels must be changed. It is thus harder to package and adapt planetary gearing systems to suit different applications, engine sizes and the like.

A further problematic area with watercraft, concerns "torque interrupt". Torque interrupt occurs when a transmission system is temporarily disengaged when the gear ratio of the transmission system is changed. One common example of torque interrupt occurs when a driver changes gear in a motor vehicle. Whilst it is acceptable to have torque interrupt in a motor car, since the momentum of the vehicle will keep the vehicle moving during the period when the transmission is temporarily disengaged, in a watercraft, torque interrupt is a more serious problem because the drag on a watercraft's hull is much greater than the frictional drag on a motor vehicle and the watercraft is appreciably slowed during any period when the transmission is disengaged.

A further problem which occurs with watercraft, is "clunking" which occurs as a watercraft is put into forward or reverse gear. Whilst it is not a serious problem from an operational point of view, clearly a person spending a large sum of money to buy a watercraft, particularly at the more expensive end of the market, might expect to get a
 5 transmission system which does not "clunk" when the craft is put into gear.

It is an object of the present invention to address or alleviate at least some of the problems of the prior art.

Any discussion of documents, acts, materials, devices, articles or the like which has been included in the present specification is solely for the purpose of providing a
 10 context for the present invention. It is not to be taken as an admission that any or all of these matters form part of the prior art base or were common general knowledge in the field relevant to the present invention as it existed before the priority date of each claim of this application.

15 Summary of the Invention

According to the present invention there is provided a two speed transmission system including a first clutch means for connecting an input shaft to a co-axial output shaft;

a lay shaft typically parallel to the input and output shafts;

20 a first gear train for connecting the input shaft to the lay shaft for driving the same via the input shaft;

a second gear train connecting the lay shaft to the output shaft;

wherein the first clutch means connects the input shaft to the output shaft; and

a second clutch means connects the input shaft to the output shaft via the lay
 25 shaft giving a gear ratio other than one to one.

Preferably the gear trains are selected to provide a higher gearing ie faster spinning of the lay shaft when the second clutch is engaged although an opposite arrangement would be possible.

The transmission may be used in a watercraft particularly, but not exclusively in
 30 a stern drive unit.

Using the present invention the problem of torque interrupt may be overcome by operating the transmission so that the first clutch is disengaged simultaneously with the engagement of the second clutch and vice versa.

A control system may be provided for controlling the first and second clutches.
 35 Amongst other inputs, the control system may receive inputs from various sensors including clutch pressure sensors, sensors measuring the speed of the input shaft and

output shafts respectively and sensors providing information relating to the position of gears in the gear trains.

One or more control valves and electro-hydraulic solenoids may be used to provide controlled clutch slip for docking and other functions where very low speeds of the order of a few knots may be desired.

The control system may also be used to control the solenoid to allow slipping of the clutch when initiating movement of the watercraft to avoid the problem of "clunking" as the boat is put into, or taken out of, gear.

10 **Brief Description of the Drawings**

A specific embodiment of the present invention will now be described by way of example only and with reference to the accompanying drawings in which:

Figure 1 is a schematic diagram of the stern of a watercraft having a bravo type stern drive transmission;

15 Figure 2 is a schematic diagram of a first stern drive transmission embodying the present invention for the watercraft of Figure 1;

Figure 3 repeats the diagram of Figure 2 with a control system superposed on the diagram;

Figure 4 is a schematic diagram of a second stern drive transmission embodying the present invention;

Figure 5 repeats the diagram of Figure 4 with a control system superposed on the diagram; and

Figure 6 is a schematic diagram of the stern of a watercraft having an alpha type stern drive transmission

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Detailed Description of a Preferred Embodiment

Referring to the drawings, Figure 1 shows the stern of a watercraft 10 having a hull 12. A stern drive unit 16 incorporating a dual clutch automated manual transmission 18 is located behind the transom 20 of the watercraft, an engine (not shown) is located inside the hull and an output shaft 22 from the engine projects generally horizontally from the stern of the watercraft provides power to the stern drive unit 16. This type of marine propulsion system is also commonly referred to as an "inboard/outboard drive".

The output shaft of the watercraft 22 spins about a generally horizontal axis. A bevel gear 24 is fixed to the distal end of the output shaft. The bevel gear 24 defined at the end of the output shaft meshes with forward and reverse bevel gears 26, 28

respectively and a dog clutch 30 moves in the direction of arrow "A" to connect a vertical output shaft 32 with the forward bevel gear 26, or in the direction "B" to connect the vertical output shaft 32 with the reverse bevel gear 28. A lower part 34 of the vertical output shaft is operatively connected to a further pair of meshing bevel gears 36, 38 which convert the vertical axis movement of the output shaft 34 to a generally horizontal shaft 40 driving a propeller or propellers 42. The above arrangement is typical of existing marine stern drive systems and is commonly known by some companies as a "Bravo" drive. The present invention is concerned with a transmission system and control means which not only provide two speed drive for the watercraft but also provide a number of other advantages over existing marine transmission systems.

Figure 2, shows a first transmission 18 embodying the present invention in more detail. Instead of being directly coupled to the lower bevel gear 36 as in most existing stern drives, the vertical output shaft 32 (which is the input shaft for the transmission 18) is connected via a first friction clutch pack 44 to a co-axial lower output shaft 46. When the first clutch is engaged the lower output shaft 46 spins at the same rate as the vertical output shaft 32. A second friction clutch pack 48 is also provided. When the second friction clutch pack is engaged, a lay shaft 56 is driven via components 52, 54 which in turn drives the lower output shaft 46 via gears 57 and 58. In the described embodiment, the gearing has been selected to provide a higher gearing ie faster spinning of the lower shaft 46 when the second clutch is engaged, however this is not necessarily the case in all embodiments and the gears may be used as overdrive or underdrive. Forward and reverse is still selected by the bevel gearing and dog clutch 30 at the head of the output shaft, so the system can provide two speeds in both forward and reverse directions.

A control system illustrated in Figure 3 is provided for controlling the dual clutches. The control system includes an electronic control unit (ECU) 60 linked to various sensors including sensors providing information to the ECU regarding the position/pressure of the clutches. The system also includes sensors 62 and 64 measuring the speed of the input shaft and output shafts respectively and sensors 66 providing information about the position of the gears, sensors 68 providing information about to the engine's throttle position, and sensors 70 providing information concerning to the temperature of the systems hydraulic fluid. Alternatively, some of this information can be collected off the common vessel/engine BUS or CAN.

Figure 3 also shows a valve body 80 containing a control valve and an electro-hydraulic solenoid 82 (more than one may be used) to activate controlled clutch slip as

described in more detail below. The pressure of the solenoid 82 can also be fed to the ECU. Figure 3 also illustrates a hydraulic pump 84 used for maintaining hydraulic pressure in the system's hydraulic controls.

5 The control system is arranged to allow slipping of the clutch to avoid the problem of "clunking" as the boat is put into, or taken out of, gear. The dog clutch will engage the input shaft with either the forward or reverse bevel gear, and the output shaft disengaged. The control system is arranged to gradually apply the clutch using an electro-hydraulic solenoid to smoothly transfer power from the input shaft to the output shaft.

10 The system of clutch slipping may also be used for docking functions where very low speeds of the order of a few knots may be desired and wherein clutch slip may be used to dissipate excess rotational speed of the output shaft to allow slower movement of the boat whilst maintaining engine speed.

15 The problem of torque interrupt is overcome by operating the transmission so that the first clutch is disengaged simultaneously with the engagement of the second clutch and vice versa, when the boat is moving.

Figures 4 and 5 illustrate a variant 18a of the transmission of Figures 2 and 3. components which are common to both embodiments have the same reference numerals. In the transmission 18a a one way clutch 100 is provided between the lay shaft 56 and the input shaft 32. This gives the advantage of a smooth gearshift without having to time a clutch swap since the one way clutch will either grab or let go depending on which gear is selected. The disadvantage of this is that reverse gear may be operated in the lower gear only.

25 Figure 6 illustrates the system in use with an "alpha" type drive instead of the bravo drive shown in Figure 1. In this case the output shaft 24 is directly connected to input shaft 32 via bevel gears 24 and 28 and forward and reverse are provided at the lower end of the drive adjacent the propeller 40 selected via a dog clutch 120.

Although the system described above incorporates two wet clutches, it would be appreciated that dry clutches could also be substituted for the wet clutches.

30 Further, although the system is described as being incorporated in the stern drive unit of an inboard/outboard marine propulsion system, it will be appreciated that the system could also be incorporated in outboard systems where the engine and transmission systems are all located behind the transom due to its compact size and light weight. It could also be used in variations of shaft drive and v-drive marine propulsion systems between the engine and the propeller.

The transmission may also be used in non-marine applications where size, cost and weight are an issue such as in fork-lift transmissions.

5 It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.

Dated this twenty first day of July 2003

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1/6

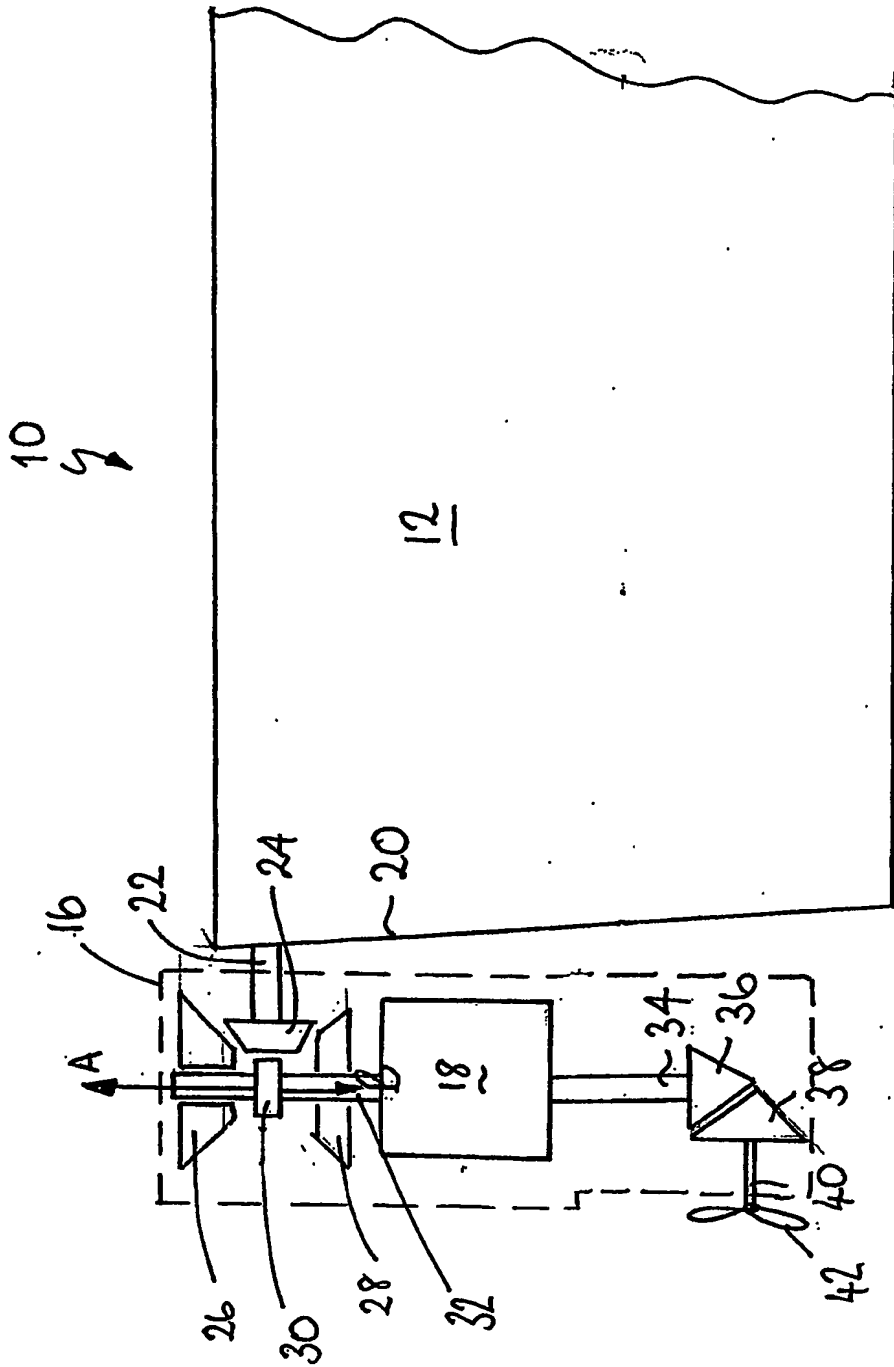


Figure 1

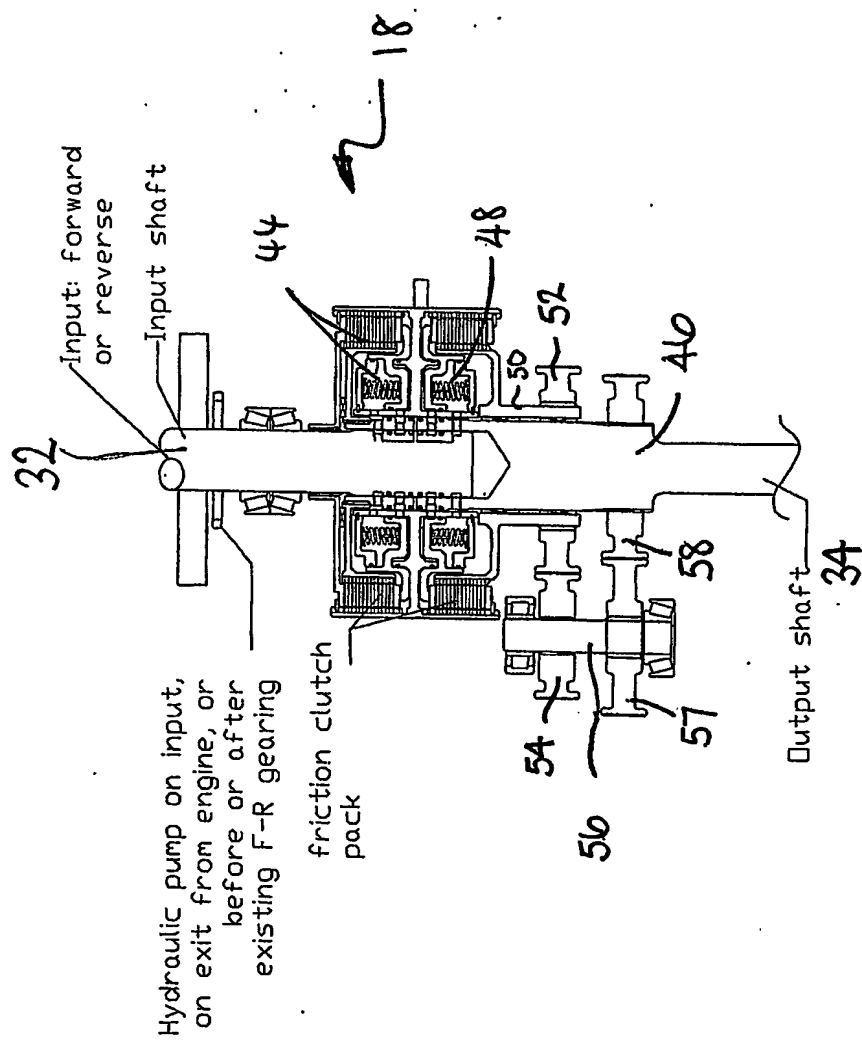


Figure 2

3/6

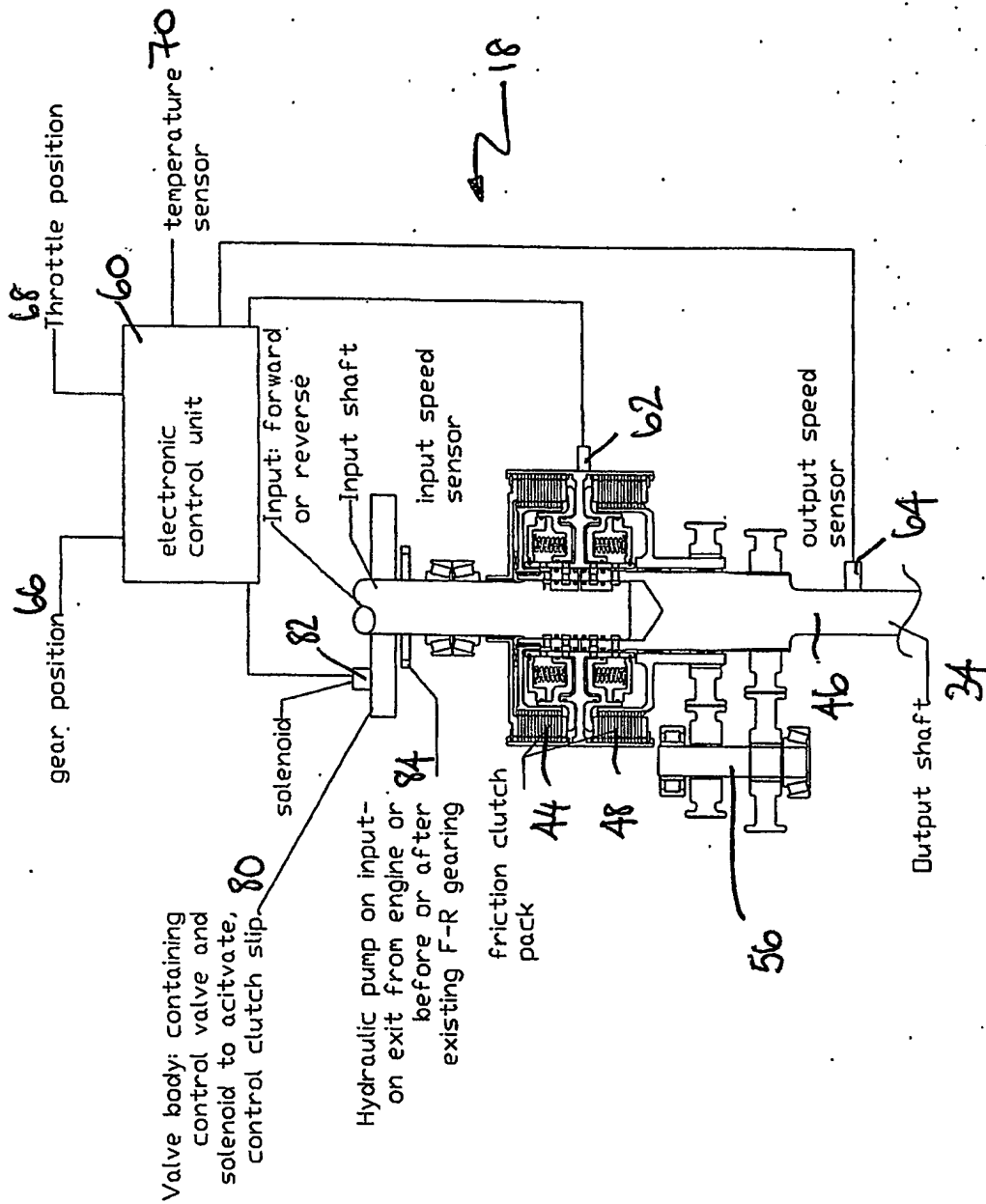


Figure 3

4/6

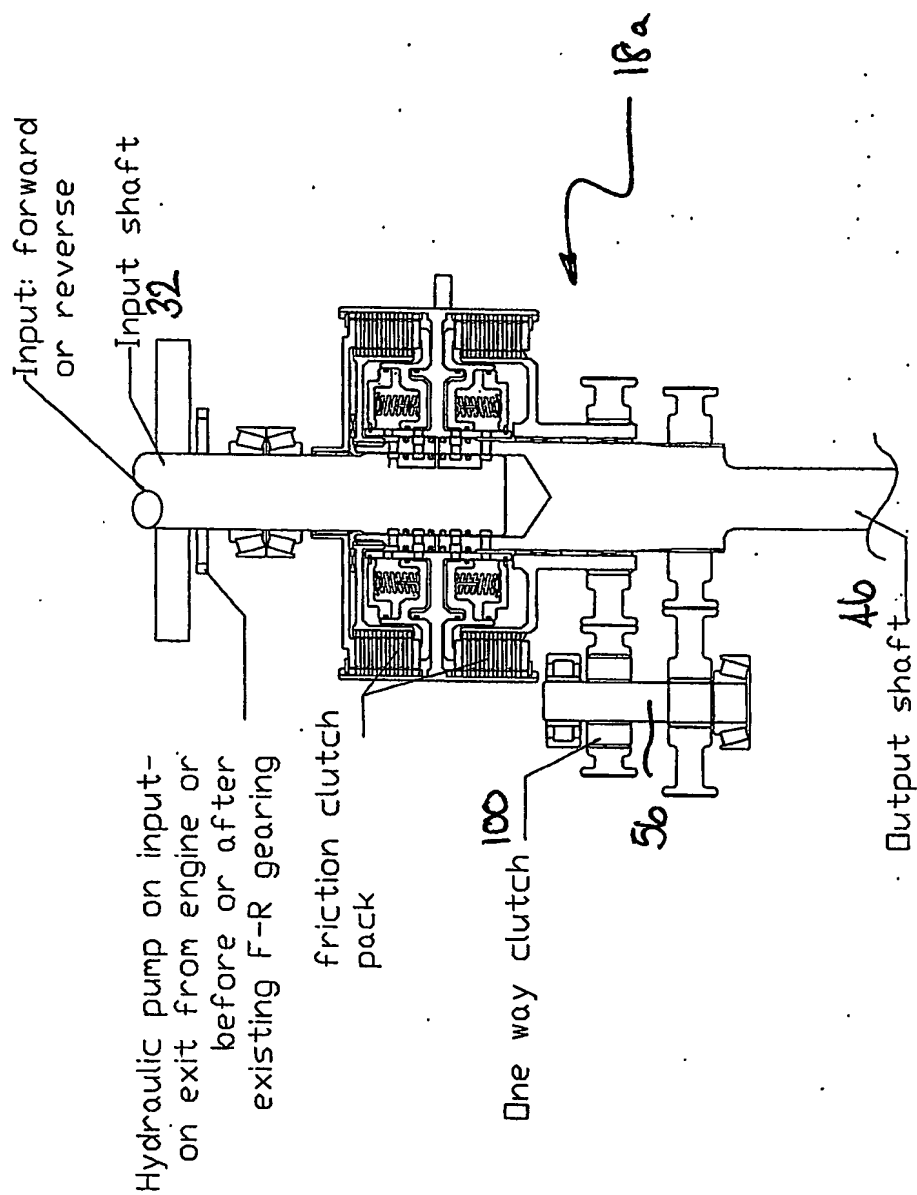


Figure 4

5/6

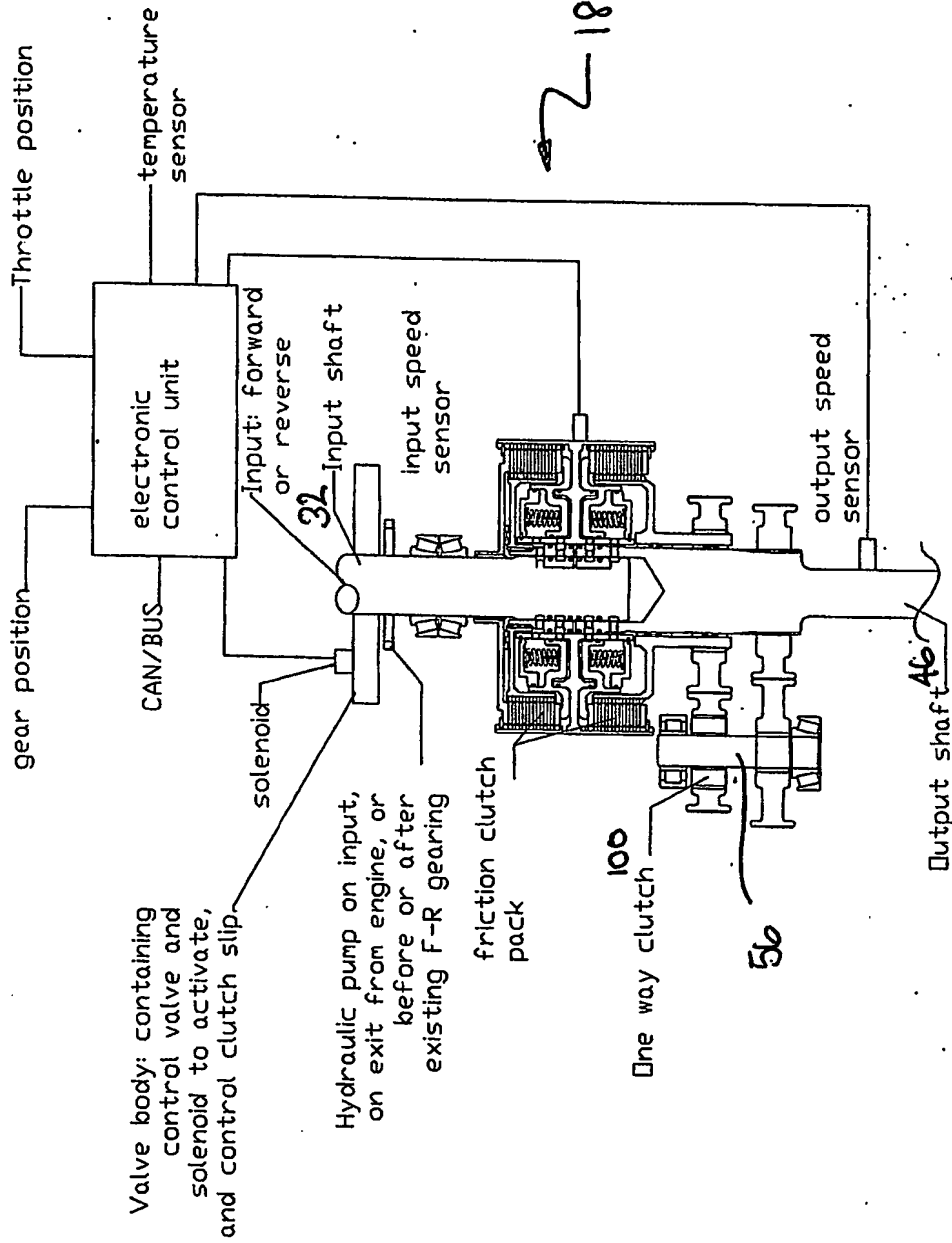


Figure 5

6/6

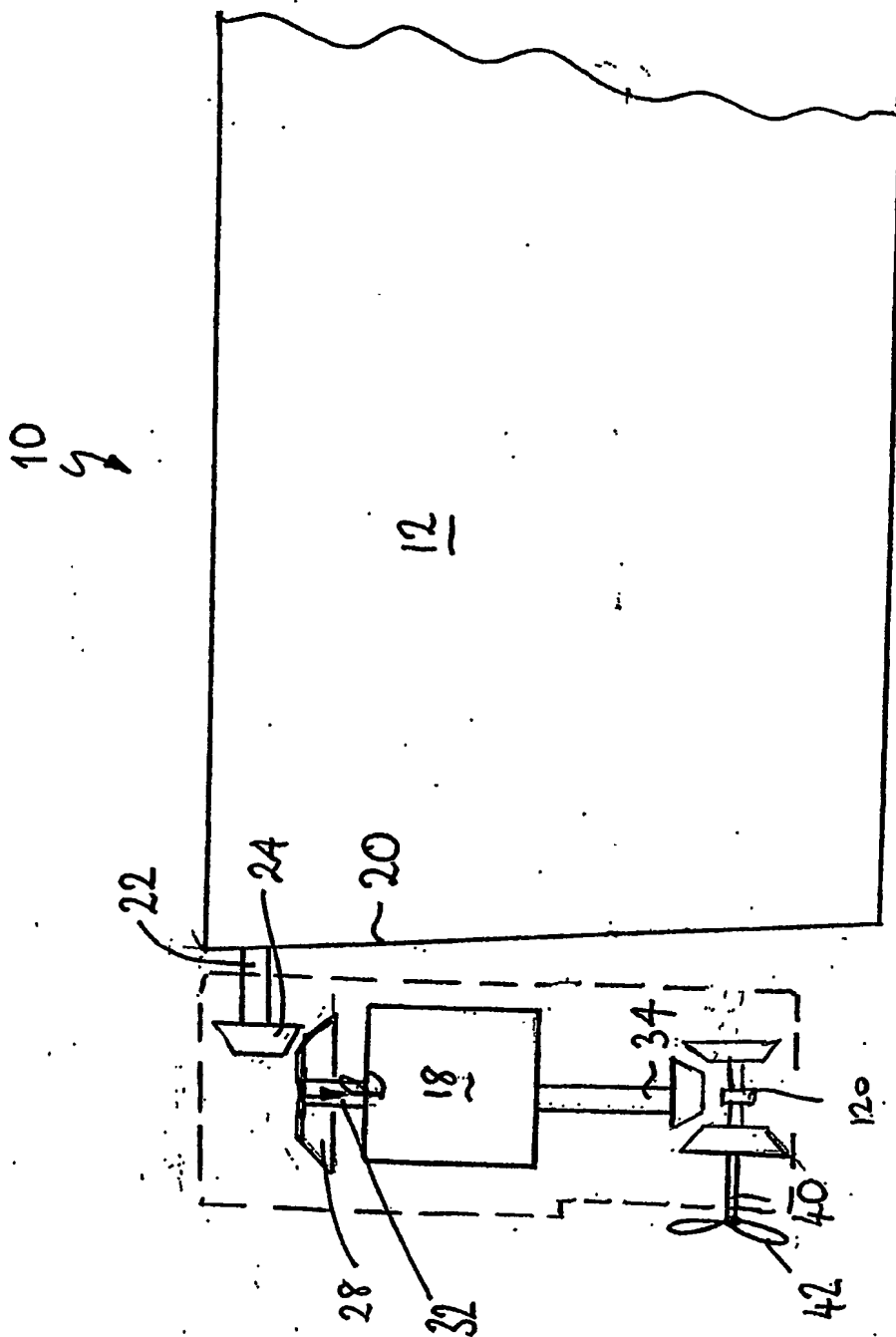


Figure 6

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